

REMARKS/ARGUMENTS

Claims 92-129 and 151-164 are pending; Claims 94, 95, 98, 124 and 155 have been withdrawn; Claims 1-91 and 130-150 have been canceled.

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Response to Claim Rejections under 35 U.S.C. 102 and 103

Applicants respectfully traverse the rejections for at least the reasons set forth below.

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Response to Claims 92-119

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As currently amended, independent claim 92 is recited below:

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92. A bonding structure on a chip comprising a pad exposed by an opening in a passivation layer, comprising:

a metal pillar over all region of said pad exposed by said opening in said passivation layer; and

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a tin-containing cap over said metal pillar, wherein said tin-containing cap has a greatest transverse dimension less than a transverse dimension of said metal pillar.

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Reconsideration of Claims 92, 93, 96, 97, 99-119 rejected under 35 U.S.C. 103(a) as being unpatentable over Ogura (US6,706,554) in combination with Burnette et al. (US6,552,436) is requested based on the following remarks.

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Applicants respectfully assert that the semiconductor device claimed in claim 92 patentably distinguishes over the citations by Ogura (US6,706,554) and Burnette et al. (US6,552,436).

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Ogura teaches that a metal post 25 is over **PART** region of an electrode pad exposed by an opening in an insulating layer 12, but fails to teach a metal pillar can be over **ALL** region of a pad exposed by an opening in a passivation layer, as claimed in claim 92. ~ See Fig. 1H ~ Applicants emphasize that said metal pillar over all
5 region of said pad exposed by said opening in said passivation layer leads said pad not exposed to the ambient, and thereby damaging said pad 14 by moisture or contaminant can be improved, which is not anticipated by Ogura but claimed in Claim 92.

Ogura teaches a pillar-shaped bonding structure is formed over an IC chip.
10 However, Burnette et al. teach a solder ball 24 or 44, not comprising a pillar-shaped pillar, is used to connect a substrate 12 or 32 and a printed circuit board 22 or 42; that is, the solder ball 24 or 44 is not formed over an IC chip. ~ See Figs. 1 and 2, and col. 1, lines 29-31 and 52-54 ~ Ogura and Burnette et al. teach different ways for bonding different circuit components.

15 The Examiner considers that "Both references deal with flip chips interconnected to a substrate. Therefore, one of ordinary skill in the art would be motivated to look at art in an effort to insure protection of its substrate's underlayers. The fact that the interconnect is a different shape does not eliminated the motive a person of ordinary
20 skill in the art looking at references that deal with problems of interconnection would have in an effort to establish the most reliable connections. For the reasons stated, applicant's arguments are deemed unpersuasive". ~ See lines 4-10, in the last paragraph, on page 7, in the Office Action mailed Jul. 25, 2006 ~

25 Applicants respectfully traverse the Examiner's opinions because **NOT** both references deal with flip chips interconnected to a substrate. Ogura teaches a pillar-shaped bonding structure is used to connect an IC chip to an external circuit component; however, Burnette et al. teach a solder ball not comprising a metal pillar is used to connect a substrate and a printed circuit board, that is, not to connect a flip
30 chip to an external circuit component. It is believed that the solder ball in Burnette et al's device for connecting a substrate and a printed circuit board can not be analogous to the pillar-shaped bonding structure in Ogura's device for connecting an IC chip to

an external circuit component.

Withdrawal of rejection under 35 U.S.C. 103 (c) to Claim 92 is respectfully requested.

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For at least the foregoing reasons, applicants respectfully submit independent Claim 92 patently distinguishes over the prior art references, and should be allowed.

10 In regards to Claim 93, the subject matter that “said metal pillar comprises copper” leads that said metal pillar has good electrical conductivity. For at least the above reasons, dependent Claim 93 patently defines over the prior art as well.

15 In regards to Claim 97, the subject matter that “said metal pillar comprises an electroplated metal” leads said metal pillar to be easily formed with a great thickness. For at least the above reasons, dependent Claim 97 patently defines over the prior art as well.

20 In regards to Claims 98 and 99, the subject matter that “said tin-containing cap further comprises lead or bismuth” leads said tin-containing cap to be a good solder. For at least the above reasons, dependent Claims 98 and 99 patently define over the prior art as well.

25 In regards to Claim 100, the subject matter that “said tin-containing cap further comprises an electroplated metal” leads said tin-containing cap to be easily formed with a great thickness. For at least the above reasons, dependent Claim 100 patently defines over the prior art as well.

30 In regards to Claim 104, the subject matter that “said tin-containing cap has a melting point lower than that of said metal pillar” leads that a great gap may exist between said semiconductor device and an external circuit. For at least the above reasons, dependent Claim 104 patently defines over the prior art as well.

In regards to Claims 106-116, the subject matter that “said metal layer comprises titanium, tungsten, chromium, copper, nickel, cobalt, silver, gold, tin, vanadium or palladium” leads said metal pillar to be firmly fixed or easily formed over said semiconductor device. For at least the above reasons, dependent Claims 106-116
5 patently define over the prior art as well.

In regards to Claim 117, the subject matter that “said metal layer comprises a sputtered metal” leads said metal layer to be formed with a thin thickness. For at least the above reasons, dependent Claim 117 patently defines over the prior art as
10 well.

In regards to Claim 119, the subject matter that “said metal pillar has a height greater than that of said tin-containing cap” leads that a great gap may exist between said semiconductor device and an external circuit. For at least the above reasons,
15 dependent Claim 119 patently defines over the prior art as well.

Response to Claims 120-129 and 163

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20 As currently amended, independent claim 120 is recited below:

120. A bonding structure on a chip comprising a pad exposed by an opening in a passivation layer, comprising:

a copper pillar over said pad; and

a tin-containing cap over said copper pillar, wherein said tin-containing

25 cap has a greatest transverse dimension less than that of said copper pillar.

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Reconsideration of Claims 120-123 and 125-129 rejected under 35 U.S.C. 103(a) as being unpatentable over Ogura (US6,706,554) in combination with Burnette et al. (US6,552,436) is requested based on the following remarks.

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Applicants respectfully assert that the semiconductor device claimed in claim 120

patentably distinguishes over the citations by Ogura (US6,706,554) and Burnette et al. (US6,552,436).

5 Ogura teaches that a metal pillar 22 comprises aluminum, titanium, tungsten, molybdenum, gold, silver, nickel, indium, or silicon. ~ See 1H, and col. 4, lines 58-63 ~ However, Ogura fails to teach, hint or suggest that the metal pillar 22 may comprise copper, as claimed in Claim 120.

10 Ogura teaches a pillar-shaped bonding structure is formed over an IC chip; however, Burnette et al. teach a solder ball 24 or 44, not comprising a pillar-shaped metal pillar, is used to connect a substrate 12 or 32 to a printed circuit board 22 or 42; that is, the solder ball 24 or 44 is not formed over an IC chip. ~ See Figs. 1 and 2, and col. 1, lines 29-31 and 52-54 ~ Ogura and Burnette et al. teach different ways for bonding different circuit components.

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The Examiner considers that “Both references deal with flip chips interconnected to a substrate. Therefore, one of ordinary skill in the art would be motivated to look at art in an effort to insure protection of its substrate’s underlayers. The fact that the interconnect is a different shape does not eliminated the motive a person of ordinary skill in the art looking at references that deal with problems of interconnection would have in an effort to establish the most reliable connections. For the reasons stated, applicant’s arguments are deemed unpersuasive”. ~ See lines 4-10, in the last paragraph, on page 7, in the Office Action mailed Jul. 25, 2006 ~

25 Applicants respectfully traverse the Examiner’s opinions because **NOT** both references deal with flip chips interconnected to a substrate. Ogura teaches a pillar-shaped bonding structure is used to connect an IC chip to an external circuit component; however, Burnette et al. teach a solder ball not comprising a metal pillar is used to connect a substrate and a printed circuit board, that is, not to connect a flip chip to an external circuit component. It is believed that the solder ball in Burnette et al.’s device for connecting a substrate and a printed circuit board can not be analogous to the pillar-shaped bonding structure in Ogura’s device for connecting an IC chip to

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an external circuit component.

Withdrawal of rejection under 35 U.S.C. 103 (c) to Claim 120 is respectfully requested.

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For at least the foregoing reasons, applicants respectfully submit independent Claim 120 patently distinguishes over the prior art references, and should be allowed.

10 In regards to Claims 123 and 125, the subject matter that “said metal layer comprises titanium or chromium” leads said copper pillar to be firmly fixed or easily formed over said semiconductor device. For at least the above reasons, dependent Claims 123 and 125 patently define over the prior art as well.

15 In regards to Claim 124, the subject matter that “said tin-containing cap further comprises lead” leads said tin-containing cap to be a good solder. For at least the above reasons, dependent Claim 124 patently defines over the prior art as well.

20 In regards to Claim 126, the subject matter that “the semiconductor device further comprising a conductive layer between said copper pillar and said tin-containing cap, said copper pillar having a height greater than that of said conductive layer” leads said tin-containing cap to be firmly fixed or easily formed over said copper pillar. For at least the above reasons, dependent Claim 126 patently defines over the prior art as well.

25 In regards to Claim 129, the subject matter that “said tin-containing cap has a melting point lower than that of said metal pillar” leads that a great gap may exist between said semiconductor device and an external circuit. For at least the above reasons, dependent Claim 129 patently defines over the prior art as well.

30 **Response to Claims 151-162 and 164**

As currently amended, independent claim 151 is recited below:

151. A bonding structure on a chip comprising a pad exposed by an opening in a passivation layer, comprising:

5 a metal pillar over said pad, wherein said metal pillar comprises a tin-silver-copper alloy; and
a tin-containing cap over said metal pillar.

10 *Reconsideration of Claims 151-154 and 156-162 rejected under 35 U.S.C. 103(a) as being unpatentable over Ogura (US6,706,554) in combination with Burnette et al. (US6,552,436) is requested based on the following remarks.*

Applicants respectfully assert that the semiconductor device claimed in claim 151 patentably distinguishes over the citations by Ogura (US6,706,554) and Burnette et al.
15 (US6,552,436).

Ogura teaches that a metal pillar 22 comprises aluminum, titanium, tungsten, molybdenum, gold, silver, nickel, indium, or silicon. ~ See 1H, and col. 4, lines 58-63 ~ However, Ogura fails to teach that the metal pillar 22 may comprise a
20 tin-silver-copper alloy, as claimed in Claim 151.

Ogura teaches a pillar-shaped bonding structure is formed over an IC chip; however, Burnette et al. teach a solder ball 24 or 44, not comprising a pillar-shaped metal pillar, is used to connect a substrate 12 or 32 and a printed circuit board 22 or 42,
25 that is, not formed over an IC chip. ~ See Figs. 1 and 2, and col. 1, lines 29-31 and 52-54 ~ Ogura and Burnette et al. teach different ways for bonding different circuit components.

The Examiner considers that "Both references deal with flip chips
30 interconnected to a substrate. Therefore, one of ordinary skill in the art would be motivated to look at art in an effort to insure protection of its substrate's underlayers. The fact that the interconnect is a different shape does not eliminated the motive a

person of ordinary skill in the art looking at references that deal with problems of interconnection would have in an effort to establish the most reliable connections. For the reasons stated, applicant's arguments are deemed unpersuasive". ~ See lines 4-10, in the last paragraph, on page 7, in the last Office Action mailed Jul. 25, 2006 ~

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Applicants respectfully traverse the Examiner's opinions because **NOT** both references deal with flip chips interconnected to a substrate. Ogura teaches a pillar-shaped bonding structure is used to connect an IC chip to an external circuit component; however, Burnette et al. teach a solder ball not comprising a metal pillar is used to connect a substrate and a printed circuit board, that is, not to connect a flip chip to an external circuit component. It is believed that the solder ball in Burnette et al's device for connecting a substrate and a printed circuit board can not be analogous to the pillar-shaped bonding structure in Ogura's device for connecting an IC chip to an external circuit component.

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Withdrawal of rejection under 35 U.S.C. 103 (c) to Claim 151 is respectfully requested.

For at least the foregoing reasons, applicants respectfully submit independent Claim 151 patently distinguishes over the prior art references, and should be allowed.

In regards to Claims 154, 156 and 157, the subject matter that "said metal layer comprises titanium, chromium and copper" leads said metal pillar to be firmly fixed or easily formed over said semiconductor device. For at least the above reasons, dependent Claims 154, 156 and 157 patently define over the prior art as well.

In regards to Claims 155 and 158, the subject matter that "said tin-containing cap further comprises lead or bismuth" leads said tin-containing cap to be a good solder. For at least the above reasons, dependent Claims 155 and 158 patently define over the prior art as well.

In regards to Claim 162, the subject matter that "said tin-containing cap has a melting point lower than that of said metal pillar" leads that a great gap may exist between said semiconductor device and an external circuit. For at least the above reasons, dependent Claim 162 patently defines over the prior art as well.

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CONCLUSION

Some or all of the pending claims are believed to be in condition for allowance. Accordingly, allowance of the claims and the application as a whole are respectfully requested.

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Applicant respectfully requests that a timely Notice of Allowance be issued in this case.

Sincerely yours,

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Winston Hsu

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